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WILLAMETTE RIVER BASIN (OREGON) WATER USE TRENDS AND ESTIMATE OF GROWTH, 1960-2010

Public Health Service
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COLUMBIA RIVER BASIN PROJECT
For Water Supply and Water Quality Management

WILLAMETTE RIVER BASIN (OREGON)
WATER USE TRENDS AND ESTIMATE OF GROWTH
1960-2010

DATE: November 5, 1962

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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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Region IX

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This working paper contains preliminary data and information primarily intended for internal use by the Columbia River Basin Project staff and cooperating agencies. The material presented in this paper has not been fully evaluated and should not be considered as final.

WILLAMETTE RIVER BASIN (OREGON)
WATER USE TRENDS AND ESTIMATE OF GROWTH
1960-2010

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A. Introductory

The purpose of this section is to describe the uses for water in which quality is important. These provide a basis for establishing water quality objectives. These water quality objectives, in turn, are used to compute the stream flow requirements needed for water quality management purposes. The following description of water uses is also the first step in making an analysis of benefits to be derived from making these water uses possible. Such benefit evaluation studies, however, will be carried out at a later stage of study.

It should be noted that there are other beneficial uses for water than those for which quality is important. These other uses are described elsewhere in this report.

Because the purpose of this section is only to establish the nature of water uses in the Willamette basin, the discussions of individual uses are limited to general descriptions of use to show that certain uses do occur and their general magnitude. Although this includes readily available data such as park locations and attendance, it is beyond the scope of this study to quantify the extent of each use in terms of detailed user statistics.

B. Fisheries

1. General

The Willamette River and its tributaries support a large amount of game fishing and provide spawning areas for migratory species of fish which constitute a valuable natural resource of the Pacific Northwest.

Reduction of the natural habitat of resident species and of spawning areas of anadromous groups has resulted from construction of dams on several water-bodies and from the effects of various kinds of water pollution. In contrast, commercial and sport fishing pressure has risen with population. Unfortunately, very few statistics are available on the number of anglers using each stream or the contribution of basin streams to commercial fish harvested outside the Willamette basin.

Most of the emphasis in this discussion has been placed on the description of the salmonids, not only because they are the most important sport and commercial fish, but also because their water quality requirements (with reference to temperature and dissolved oxygen) are more critical than other species. By using their requirements as a design criteria the requirements of other species will also be met.

The data and conclusions presented in the following parts of this section are based on discussions with the U. S. Fish and Wildlife Service and publications of state conservation agencies.

2. Present Situation

a. General

Adverse pressures on fish populations are heavy as a result of fishing and the effects of civilization on environments. Trout populations behind dams frequently give way to scrap fish, which are better adapted to reservoir conditions, and displace trout through their consumption of fry and food resources. Perhaps more serious is the situation of anadromous species which use the upper areas as a spawning ground. Production is now limited to the spring run; low summer water flow and low dissolved oxygen

levels prevent a fall run. Flood control dams have closed off much of the natural spawning ground; and embankments, erosion, irrigation canals, and heavy municipal and industrial wastes on some reaches of the river have either destroyed spawning areas or added to the hazards of migration.

Despite these hazards to the fishery, the Willamette River basin has an important and widespread distribution of salmonids and other game fish. The distribution of the salmonids among the major water bodies in the basin is shown in Table I.

The use of the fishery of the Willamette River basin cannot be described precisely. Although comprehensive fishing statistics are not available, there is evidence to indicate that the number of anglers is growing. For Oregon, as a whole, the number of fishing license applications rose at a six percent annual rate during the 1950's.

TABLE I

Distribution of Salmonid Game Fish in Major Water Bodies of the Willamette Basin 1/

	Trout					Salmon		
	Rainbow	Brook	Dolly Varden	Cut-throat	Steel-head	Chinook	Coho	Kokanee
Upper Basin								
Willamette River								
Main Stem	x			x	x	x	x	
Middle Fork	x		x	x	x	x		
Coast Fork	x			x		x		
McKenzie River	x		x	x		x		
Long Tom River	x			x				
Cottage Grove Reservoir	x			x				
Dexter Reservoir	x			x				
Dorena Reservoir	x							
Fern Ridge Reservoir				x				
Lookout Point Reservoir	x			x				
Middle Basin								
North Santiam River	x	x		x	x	x	x	
South Santiam River	x			x	x	x	x	
Pudding River	x			x				
Luckiamute River	x			x			x	
Rickreall Creek	x			x				
Marys River	x			x				
Mill Creek	x			x				
Yamhill River	x			x		x	x	
Long Tom River	x			x				
Willamette River	x			x	x	x	x	
Calapooya River	x			x	x	x	x	
Cascade Lakes	x	x	x	x				x
Detroit Reservoir	x	x						x
Lower Basin								
Willamette River	x			x	x	x	x	
Clackamas River	x		x	x	x	x	x	
Molalla River	x			x	x	x	x	
Tualatin River	x			x	x	x	x	
High Mountain Lakes	x	x	x	x	x			

1/ Sources:
Oregon State Game Commission, Fishery Division: Annual Report, 1960.
Fish Commission of Oregon: Environmental Survey Report Pertaining to Salmon and Steelhead in Certain Rivers of Eastern Oregon and the Willamette River and its Tributaries, June 1960.

Another example of the growth in numbers of anglers can be seen in the statistics for the Detroit Reservoir which is considered by the Oregon State Game Commission to be a representative area. 1/ The nature of this growth is indicated in the table which follows:

TABLE II 2/

Angler Use of Detroit Reservoir

Year	Anglers
1954	49,062
1955	61,738
1956	64,787
1957	91,660
1958	97,950
1959	108,753
1960	134,331

As described in the following sections both the upper and middle basin areas contain important spawning areas for anadromous salmonids, as well as resident populations of salmonids in both the tributaries and main stem of the Willamette. The lower basin area generally lacks a resident salmonid population in the main stem, but has spawning areas on the tributaries in addition to providing passage to upstream areas.

b. Upper Willamette

There is no commercial fishing in the upper Willamette basin, but the game fishing resources of the area are considered excellent. The McKenzie River is one of the nation's famous fishing streams; the mountain lakes and streams of the Willamette National Forest and the forks and major tributaries of the Willamette River are heavily fished.

1/ Oregon State Game Commission: Statement Concerning the Fish and Wildlife Resources of the Middle Willamette Basin (delivered to the Oregon State Water Resources Board), November 1961.

2/ Oregon State Game Commission, Fishery Division: Annual Report, 1960.

Although an occasional chinook is taken behind Lookout Point or Dorena Dam, the McKenzie River is the only major spawning area remaining in the upper Willamette basin and presently accounts for about half of the total Willamette River salmon production.

The State of Oregon operates two salmon hatcheries in the upper basin area, - one at Leaburg on the McKenzie and one at Oakridge on the Middle Fork; an egg-collecting station at Dexter, and trout-breeding farms on the McKenzie and at Oakridge.

c. Middle Willamette

Although the take of fish in the middle Willamette basin is exclusively for sports purposes, the water bodies of the basin have relevance to commercial fisheries in that they serve as passageways and spawning grounds for migratory salmon, upon whose existence an important regional industry depends. Since the major spawning grounds are in the upper basin, passage through the middle basin is necessary to maintenance of this resource.

The waters of the middle basin support extensive recreational fishing, and natural stocks must be supplemented in many cases by hatchery-reared fish. Nearly all of the game fish species found in the State of Oregon are represented in the fish population of the basin. Spring run chinook and coho salmon and steelhead trout annually migrate into the Willamette and many of its middle basin tributaries. Rainbow, dolly varden, cutthroat, and brook trout frequent the basin. Whitefish occur in some tributaries. Warm-water game fish are present in all of the lower streams and reservoirs, and include largemouth, smallmouth, and warmouth bass, white and black crappie, bullhead catfish, and bluegill.

d. Lower Willamette

The waters of the lower Willamette basin support a considerable game fishery, serve as the entrance to spawning grounds in the upper reaches of the river system, and maintain a modest and irregular amount of commercial fishing.

A variety of species are found in the region. In addition to the salmonids described in Table I, warm-water game fish, including sturgeon, crappie, bass, sunfish, and catfish, are found in various rivers, backwaters, and lakes.

Because it forms the gate for migratory fish passing from or into the Columbia River, the lower Willamette is of critical importance to maintenance of Willamette River system salmon and steelhead runs.

Because of the dense population of the lower basin, there is a large use of the area's streams for sport fishing. This is indicated in the long-term statistics maintained for the lower basin by the Oregon State Game Commission, as illustrated in Table III.

TABLE III

Willamette River Spring Chinook Sport Fishery

Year	Total Run (no. of fish)	Angling Density (man days)
1950	24,800	73,400
1951	49,600	92,600
1952	67,500	91,100
1953	96,800	102,805
1954	44,400	104,061
1955	32,500	77,656
1956	77,600	84,100
1957	52,800	95,458
1958	62,800	137,875
1959	53,400	134,089
1960	24,200	92,278

It should be noted that the secular decline in the salmon run has persisted despite restrictions on commercial fishing inaugurated in the early '50's, some shortening of the sport fishing season and catch limit, and intense seeding efforts of State and Federal conservation agencies.

3. Potential Situation

Future development of the basin's fisheries would appear to depend to a great extent on public policy. Depletion of game fish populations through heavy fishing and alteration of environment is being combatted by various agencies.

Research into environmental conditions may result in appearance of other species (e.g., an experimental planting of sockeye salmon in the Middle Fork of the Willamette appears, provisionally, to have been successful). Species presently living in the basin's waters are presumed to persist through the study period. Augmentation of anadromous populations in the upper basin might well result from downstream measures to improve migratory conditions, including maintenance of water quality standards favorable to salmon.

The Fish Commission of Oregon has outlined a series of recommendations intended to promote numbers of salmon and steelhead,[1/] in the belief that the middle basin appears able to provide additional spawning areas along the Yamhill, Luckiamute and Santiam river systems, and perhaps even support a fall run of salmon in certain streams.

1/ Fish Commission of Oregon: Environmental Survey Report Pertaining to Salmon and Steelhead in Certain Rivers of Eastern Oregon and the Willamette River and its Tributaries, June 1960.

The lower basin also offers some opportunity to increase fish populations.

It is considered that fall runs of salmon may be established in the Clackamas and Tualatin rivers, in the event that storage projects augment present depleted summer flows. Improved water quality at Willamette Falls, where fish passage is delayed, would aid escapement of migrating salmon and steelhead, and improve spawning levels in upper areas of the basin.

4. Water Quality Need

The desirability of maintaining fisheries is well recognized, with considerable sums expended by various government agencies to maintain hatcheries, passageways, seeding efforts, and research. Provision of water quality sufficient to permit year-round passage of migratory fish in the lower Willamette River and to support salmonids and other species in all other streams and major water bodies of the basin is needed in order to serve this use of water in the Willamette basin.

For the purposes of this report, and based on discussion with the U. S. Fish and Wildlife Service and information obtained from state conservation agencies, the water quality required in the main stem of the Willamette in the lower basin should be adequate to permit year-round passage of migratory fish, and that of all other major streams and water bodies of the Willamette basin should be adequate to support both resident and anadromous salmonid populations.

C. Recreation

1. General

The recreational uses of water to be considered in this section include boating, swimming and bathing, skin diving, water skiing, recreational shore uses, and other similar uses of water.

As described in the following sections for individual study areas, all of the streams and major water-bodies in the Willamette basin support recreational uses despite, in some cases, very low water quality. The demand for these uses is expected to grow.

Although user statistics which are available for public or government operated recreational areas are included in the discussion of individual sections of the basin, there are many other areas of private or informal nature which also contribute to the recreational use of water in the basin. Attendance figures at public parks provide a sketchy insight into recreational use of waters. The fact that the major rivers are all accessible at a number of points where no record of use is made gives such use figures value only in indicating trends rather than establishing use levels. The existence of considerable areas of riparian settlement at places along the Willamette and its tributaries and the existence of diving boards, floats, and boats in conjunction with many of these residences is further evidence of the desire for recreational use of water.

A further complicating factor encountered in evaluating recreational use of water is suggested in the sections dealing with recreation in the individual study areas. There is apparently a considerable latent demand for recreation opportunities that is stimulated by the existence of

facilities. It would appear that the level of recreational demand is not only somewhat higher than available resources can adequately support, but that additions or improvements to recreational facilities tend to raise the level of requirements by calling forth additional users and increasing the intensity of use by current users.

Although there appears to be a demand for the recreational use of water on all of the area's streams, it is not considered likely that it will be possible to provide enough stream flow to provide adequate water quality for all recreational uses for all stretches of all streams. For instance, immediately below major points of waste discharge (even though adequately treated) or areas of uncontrolled drainage there may be limited areas where quality will be impaired sufficiently to restrict some recreational uses of the stream, even though very large stream flows are made available. Because of the problems, and because it is not practical at this time to describe the use and demand for each type of recreation for each stretch of stream, it is considered to be reasonable to examine the problem from the reverse viewpoint, i.e. what level of recreation will be permitted if the flow requirements for other uses are met? The amount and types of recreation which such flow requirements will permit will then need to be evaluated to see if the area's apparent needs will be met.

2. Present Situation

a. General

Although use statistics are sketchy and provisional, they indicate that the recreational facilities of the Willamette basin are receiving increasingly intensive use. Population growth and an apparent increase in

per capita participation in outdoor recreation is creating a strain on many facilities. For example, on the peak boating day on Fern Ridge Reservoir in 1958, as reported by the U. S. Army Corps of Engineers, there were 100 craft on the water. Information from resort and county park personnel, however, indicates that during July and early August 1962, 300-350 craft were on the reservoir every weekend day, and an additional launching facility at Zumwalt County Park was required to handle the growing number of boaters. Similarly, the number of users of the picnic ground and boat launching facilities of North Shore Park on the Dexter Reservoir climbed from a reported 45,000 in 1958 to a reported 135,000 in 1960.

In addition to increasing demands from the area's residents, visitors also were significant users of the water recreation opportunities of the basin. Tourism became Oregon's second source of income in 1961, supplanting agriculture in that position, according to the State Department of Industrial Development; and much of the fixed investment in the state during the late '50's and early '60's has been directed to the tourist industry. There is an obvious willingness for boaters, campers, and even picnickers to travel considerable distances, when necessary, in pursuit of recreation. [e.g., An enumeration of users of recreational facilities maintained by Pacific Power & Light Company on the Lewis River in southwest Washington indicates that 55 percent of the users over a period of years (1959-1962) came from Oregon. At present rates of use, over 50,000 visitors annually travel a minimum of fifty miles each way to the Lewis River area to enjoy picnicking and boating.] Thus increasing use of basin recreation sites by tourists would seem likely in the future. In addition, the

improvement of the basin's recreational opportunities would, in many cases, save the area's residents considerable time and travel expense.

b. Upper Willamette

Water-based recreation activities are abundant in the upper Willamette basin. Private firms, federal agencies,the State of Oregon, Lane County, and the municipalities of Eugene, Cottage Grove, and Oakridge all maintain recreation facilities of some type. Water-side picnicking and camping facilities are abundant. Many swimming opportunities are present in the clean waters above Eugene. Six large reservoirs provide boating opportunities, and the rapids of the McKenzie are used for "whitewater" boating. For the most part, recreational facilities are readily accessible from major highways, though the distance from population centers makes a trip to some forest, stream, and reservoir locations an extended day's outing; while the scarcity of camping facilities - other than those in the National Forest - discourages over-night excursions. The remote lakes of the Willamette National Forest are little used for boating because of their inaccessibility. Conversely, there is some swimming in the Willamette near Eugene, although the river is officially closed to swimmers.

The following table summarizes by stream the major water-based recreation facilities in this area.

TABLE IV

Attendance at Water-based Recreation Sites in the Upper Basin

	1950 [a]	1958 [a]	1961
Willamette, Coast Fork			
Cottage Grove Reservoir	49,300	56,000	117,300 [b]
Dorena Reservoir	19,800	32,000	39,000 [b]
Baker Bay Co. Park (Dorena Res.)		80,000	n.a. [e]
Long Tom River			
Zumwalt Park)			
Perkins Peninsula)	134,700	213,000	437,900 [b]
Richardson Point)			
McKenzie River			
Armitage State Park	34,437	110,720	129,465 [c]
Hendricks Bridge State Park	2,190	34,362	45,030 [c]
Ben and Kay Dorris State Park	705	25,764	22,431 [c]
Howard J. Morton State Park		6,339	6,147 [c]
Jennie B. Harris State Park		3,765	4,504 [c]
Weyerhaeuser Park		6,000	n.a. [e]
Leaburg Park		45,000	n.a. [e]
Blue River Park		4,000	n.a. [e]
Willamette, Middle Fork			
Lookout Point Reservoir		136,000	91,300 [b]
Dexter Viewpoint		25,000	n.a. [e]
Dexter North Shore		45,000 [c]	135,000 [d]
Oakridge Municipal Park		n.a. [c]	n.a. [e]

[a] Columbia Basin Inter-Agency Committee: Recreation Survey of the Pacific Northwest Region, March 1961.

[b] Corps of Engineers, Department of the Army: Public Recreation Use, Civil Works Projects, May 1962.

[c] Oregon State Highway Commission - 1960 figures.

[d] Lane County Bureau of Parks and Recreation - 1960 figures.

[e] Not available.

c. Middle Willamette

Recreational use of water - other than fishing - is less intensive in the middle Willamette basin than in either the upper or lower basin. In large measure, it would appear that the relatively low use of water for recreation in the area may be traced to scarcity of opportunities.

The number of water-side recreation areas in the middle Willamette basin is not high, and their quality is generally under that of neighboring areas. This is due to the existing character and quality of streams, which are mainly shallow, slow-flowing, very low in summer months, often turbid, and frequently polluted. At some recreational areas such as Newberg Boat Landing, Champoeg State Park, and Lafayette Locks County Park, the water is posted against swimming. It might be said that under present conditions only the Santiam and its forks, Detroit Reservoir, and some Cascade lakes are suitable for swimming; while Detroit Reservoir and the Willamette River are the only bodies large enough to permit boating.

Table V summarizes main water-side recreation areas in the middle Willamette basin.

TABLE V

Attendance at Water-based Recreation Sites in the Middle Basin

	1950 a/	1958 a/	1960 b/
Silver Creek			
Silver Falls State Park	182,432	199,578	208,520
North Falls State Park	--	30,462	63,412
Willamette River			
Champoeg State Park	42,345	109,769	99,234
Sodaville Springs State Park	6,792	2,568	2,145
Santiam River			
Cascadia State Park	193,383	75,835	83,967
North Santiam River			
Detroit Reservoir			
Lakeshore State Park		81,891	138,066
Mongold State Park		66,534	99,018
North Santiam State Park		32,691	31,092
Niagara County Park	n.a. c/	n.a.	n.a.
Buell County Park	500	5,050	n.a.
Yamhill River			
Dayton Landing County Park	n.a.	n.a.	n.a.
Lafayette Locks County Park	n.a.	n.a.	n.a.
Marys River			
Avery Municipal Park	n.a.	n.a.	n.a.

It is notable that most of the growth was centered on the Detroit Reservoir, with its extensive swimming and boating opportunities. Attendance at other areas appeared to drop off as the relative advantages of the Detroit Reservoir parks were realized. It may be worth particular note that attendance at Champoeg State Park dropped about 10.5 thousand from 1958 to 1960. Located at a slow-moving pool on the Willamette, a short area downstream from the places where the municipal wastes of Newberg and

a/ Columbia Basin Inter-Agency Committee: Recreation Survey of the Pacific Northest Region, March 1961
b/ Oregon State Highway Commission
c/ Not available

the affluent of a pulp plant are released, the park provides an example of less than optimum use of potential recreational opportunity due to low water quality.

d. Lower Willamette

The population of the lower Willamette basin uses the recreational water resources of the area extensively despite the low water quality of the area's principal water body. The population of the area also exerts considerable pressure on surrounding areas in their attempt to satisfy the recreational demand. The Clackamas River is a clean, attractive, swift-flowing stream that provides swimming and fishing. The Willamette receives heavy use by boaters, and the Willamette above Oregon City is much used by swimmers. The sluggish, turbid Tualatin is used by swimmers at public resorts and by residents. The Molalla River is utilized by swimmers, and picnicking is common along its banks. Lake Oswego was developed as an area for recreational living; and though the public recreation area has been usurped by housing, residents make heavy use of the waters for boating, swimming and water skiing. There are two public resorts on the Tualatin, three on the Clackamas, at least fourteen moorages and marinas on the Willamette, and two on Lake Oswego. Attendance at parks in the area is shown in Table VI.

TABLE VI

Attendance at Water-based Recreation Sites in the Lower Basin

	1950 [a]	1960
Sandy River		
Dabney State Park	81,615	109,371 [b]
Lewis & Clark State Park		67,245 [b]
Molalla River		
Barlow Trail County Park	n.a.	n.a. [d]
Deep Creek		
Deep Creek County Park	n.a.	n.a.
Eagle Creek		
Eagle Fern County Park	n.a.	n.a.
Metzler County Park	n.a.	n.a.
Clackamas River		
Feyrer County Park	n.a.	n.a.
Wagon Wheel County Park	n.a.	n.a.
Willamette River		
Clackamette Municipal Park	n.a.	n.a.
Estacada Lake		
River Mill Park		4,270 [c]
Lake Harriet		
Lake Harriet Park		
N. Fork Reservoir		
Promontory Park		75,000 [c]
Roslyn Lake		
Roslyn Lake Park		15,875 [c]
Timothy Lake		
Gone Creek Park)		
Hood View Park)		18,256 [c]
Meditation Point Park)		
Clackamas River		
Austin Hot Spring		31,345 [c]
Blue Lake		
Blue Lake County Park		

a/ Columbia Basin Inter-Agency Committee: Recreation Survey of the Pacific Northwest Region.
b/ Oregon State Highway Commission.
c/ Portland General Electric Company
d/ Not available

3. Potential Situation

In addition to a growing per capita use of the area's water based recreational facilities by the present residents, several other factors will also be significant in determining the potential demand for these facilities. Industrial development groups are stressing Oregon's ability to offer intangible social benefits, recreation among them, as an inducement to recruiting new industries and high quality industrial personnel. There are indications that this appeal is effective and it presents the possibility of rising demand for recreational opportunities from an immigrant work force attracted partly by recreational considerations. Also posing the possibility of growing demand pressures is the fact that the basin's relatively abundant recreational resources are likely to attract increasing numbers of visitors from other areas where natural recreation facilities are less abundant.

In the upper basin area the fishing possibilities of the McKenzie River and the moderately used reservoirs on the North Fork of the Willamette offer room for expanded use. The principal area of unsatisfied demand would appear to be for the use of the Willamette River near Eugene for swimming. Expansion of the Eugene-Lane County park system along the banks of the river will unquestionably give rise to added pressures from potential swimmers, particularly when the saturated level of use of Fern Ridge Reservoir, the only considerable body of swimming water close to the metropolitan area, is taken into account.

The growing population envisaged for the middle Willamette basin will unquestionably make considerable demands on the limited recreational

water resources of the area. In view of the rising number of potential users and the trend of visits per person, the presently available fishing, boating, and swimming facilities of the middle basin should become saturated in the very near future. (Some evidence of this is indicated at Detroit Reservoir where it was necessary to zone its waters in 1960 to accommodate both anglers and water-skiers.) Power-boating and swimming opportunities on such narrow, sluggish streams as the Luckiamute, Marys River, Rickreall Creek, and the Yamhill River will always be limited.

The main potential body of recreationally useful water which can be made available to the population of the middle Willamette basin is the Willamette River. Making the Willamette available for swimming over its middle areas would unquestionably absorb considerable recreational demand and stave off for some time the need for the population of the middle basin to resort to other areas in search of suitable recreational water bodies.

Greater recreational use of the Willamette below Willamette Falls is restricted for many types of recreation, due to the industrialized character of the river bank in many areas. Above Willamette Falls, measures to reduce turbidity might make increased recreational use possible and desirable, in spite of the impediment offered by huge lengths of log rafts characteristic of this portion of the river.

Further development of the recreational possibilities of the Clackamas ' likely. The Tualatin River's recreational possibilities are limited, due to the turbidity and slow flow of the river. Added upstream storage could produce in the Tualatin a wholly new recreation area.

The desire for recreational use of water is intense in the lower basin, where an urbanized population is keenly aware of the attractions of water sports. Because other uses would appear to restrict recreational development in some portions of the lower Willamette River, water management programs for other water bodies should reflect the need for developing additional recreational possibilities. Rising population levels in conjunction with the trend to make more extensive use of recreational water indicate that maintenance of water quality in the interest of recreation will, in the future, become an increasingly pressing problem in the lower Willamette basin.

D. Riparian Dwellings

1. General

The degree of riparian settlement correlates rather directly with two factors, the level of recreation opportunities available on a water body, and the proximity to a population center. It is expected that as populations increase along the Willamette, the prevalence of waterside dwellings will grow at a somewhat faster rate than the historical rate.

Although there are no direct water quality requirements for riparian dwellings, their desirability and land value depend in part on the recreation possibilities of water and in part on the aesthetic qualities of the waterbody and its banks. The existence of riparian dwellings oriented towards a stream is a useful indicator that a demand for recreational and aesthetic enjoyment of the stream exists. Erosion, turbidity, unsightly or odoriferous conditions, or water quality too low to support recreation may be presumed to have an adverse effect on riparian settlement and the value of riparian residential land.

2. Present Situation

a. Upper Willamette

The establishment of dwellings by lakes or streams of the upper Willamette basin has only occurred in a few areas. Farm homes are for the most part oriented to roads rather than water, and the Willamette near Eugene-Springfield is largely vacant or left to industrial sites.

Exceptions are observable, however; and there appears to be a definite tendency for areas with water-based scenic or recreational attractions to become built-up. With the exception of the McKenzie River area, where recreational considerations have resulted in resort type of development, water-side building has taken place where nearness to urban areas and ease of access are marked.

Houses are spaced along the McKenzie River from Springfield to McKenzie Bridge, a distance of about fifty miles. The seven settled places along the river are all oriented to the stream. A dozen fishing resorts and scores of summer homes line the river from Leaburg to Blue River. All in all, perhaps two hundred dwelling units stand along the McKenzie. At Lowell fifteen homes, roughly a quarter of the dwelling units in the town, have been built on the bank of Dexter Reservoir. Farm houses above Cottage Grove Reservoir are largely located near and facing the reservoir; while the six miles of streamside from Dorena Dam to Cottage Grove has many dwellings. Fall Creek, from just outside Springfield for about thirteen miles, is built up with farm homes, other residences, and some summer cottages.

Fern Ridge Reservoir, Eugene's main recreation area, provides the best example of settlement near water. The west bank of the reservoir has a number of summer homes and year-round dwellings, and a cluster of recently built houses stands near the east bank.

b. Middle Willamette

The use of water-side sites for residential dwellings is relatively scarce through most of the countryside of the middle basin, and are limited to places near towns or cities. Though farm boundaries often include streams, the predominant pattern has the farm home located near a road or highway, rather than in view of the stream. In those cases where a town is located on a river - St. Paul, Dayton, Independence, Peoria, and Harrisburg - the backs of buildings are in most cases turned to the river, their fronts to the road. In the cities of Salem and Albany, the riverside is largely undeveloped or given over to industrial uses.

There are exceptions, however, provided by some urban areas where residential emplacements exist along river banks and display a definite desire to make use of the scenic and recreational resources of the water body. Outside of Corvallis several dozen dwellings may be observed along the banks of the Willamette River and Marys River. In several instances, private moorages are situated near Willamette River homes. Both Sweet Home and Lebanon on the South Santiam River have fairly new residential suburbs reaching up from the river. Outside of Newberg, perhaps a dozen houses have been built along the Willamette River. Here, too, several houses are connected to pleasure-boat docks.

c. Lower Willamette

Water-side dwelling places are generally regarded as desirable in the highly urbanized lower Willamette basin. Dwelling structures occupy much of the non-industrial land on the banks of the Willamette from the Ross Island Bridge to some distance past Oregon City, a distance of about fifteen miles. Lake Oswego, an impoundment adjacent to the mouth of the Tualatin River, has become the center of an incorporated suburb with a 1960 population of 8,906. The community's population growth, from 3,316 in 1950 and 1,726 in 1940, is dramatic testimony to the desire for water-side dwelling. The lower reaches of the Clackamas River have a considerable number of homes. Over two hundred houses obviously oriented to the stream - many with connected floats and diving boards - exist along the Tualatin. Pressure of desire for water-side land is so intense in the area about Portland that prevailing custom calls for prices for riparian homesites to be quoted in terms of running feet of water-front land, rather than over-all area.

3. Potential Situation

The population of the upper basin has been projected to more than double by 2010, with the Eugene-Springfield area expected to remain the principal focus of settlement. The social forces that have contributed to the desirability of water-side locations show no sign of abatement. It would appear likely, then, that attractive water-side areas adjacent to the Eugene-Springfield urban core, and readily accessible by automobile, will become increasingly built-up. The banks of Fern Ridge Reservoir, the main stem of the Willamette both above and below the Eugene area, and the

Coast Fork of the Willamette near Cottage Grove appear to be likely sites for residential housing. The McKenzie and North Fork of the Willamette offer a number of suitable areas for construction of summer cottages.

The experience of the upper and lower areas of the Willamette basin suggests some future growth for streamside settlement in the middle basin. Although the present incidence of riparian dwelling is low, it appears highly likely that this may be attributed in part to a high proportion of rural population and also to the level of recreational opportunities present on those streams. The development of urban pressures as a result of population expansion in Salem, Corvallis, Albany, Newberg, Lebanon, and Sweet Home will result in the appearance of concentrations of riverside homes. In addition, if the Willamette River were to become available for more intensive recreational use at some future date, then the emplacement of homes along its banks would occur at an accelerated pace.

Although the greater portion ofwater-side land in the lower basin is already occupied, further settlement along the Clackamas and Tualatin Rivers would seem likely.

E. General Public

The uses of water which are in this category are intangible in nature and consist of the uses by, or influence on, the public at large rather than on those specific uses described in previous sections. In this category are included the effect of the water bodies on the surrounding environment including scenic areas, residential areas, and public thoroughfares. The manifestation of this influence would be in terms of the effect on morale, community pride, worker productivity, and physical and mental health of

residents and general satisfaction and impression received by tourists and other travelers. In the Willamette Basin, these consideratins are particularly important because the Willamette River runs through every major community and is thus adjacent to the majority of the basin's population. At Portland, for example, it splits a metropolitan area containing 728,000 people. In addition, as described in the section on recreation, the tourist industry is a major economic force in Oregon and its continued existence is based on providing a pleasing aesthetic impression.

It should be noted that the effect or influence of water quality in this category is not always dependent upon contact or even frequent observation of the quality. The knowledge that gross stream pollution exists, for instance, can be distasteful to the general public in an area even though the polluted water cannot be readily observed.

For the purposes of this analysis, the water quality to be sought for this category of use should be as high as is reasonably possible in all of the basin's streams and major water bodies. Of particular importance will be to provide a quality which is not injurious to the health of the various users and which is visually attractive. It is considered reasonable to assume that if the previously described water quality objectives for recreational and fishery use of the basin's streams are met, the resulting quality will also be adequate for the category of general public considerations.

F. Power

In this category of water use are included both hydroelectric applications and thermal applications. The importance of quality to the former is due to the possibility of corrosion damage to structures and equipment. This damage is considered to be too minor in the study area to be influential in setting water quality goals. The importance of quality in thermal applications is discussed elsewhere in this report in the section on industrial water supplies.

G. Navigation

Navigational uses of water are quite tolerant in their quality requirements, with avoidance of corrosion being the principal concern. This damage is considered to be too minor in the study area to be influential in setting water quality goals.

H. Irrigation and Other Agricultural Uses

Water quality is of considerable importance to irrigated agriculture and for such other uses as stock watering. Because of their similarity to other water supply problems, however, irrigation withdrawals and quality requirements have been examined elsewhere in this report.

I. Municipal and Industrial Water Supply

The water quality requirements for municipal and industrial water supplies are an important consideration in determining water quality objectives and computing stream flow requirements. The quantity and quality requirements of this water use, however, are examined in the

sections of this report concerned with engineering data and computations.

J. Conclusions

The level of water quality to be maintained in the Willamette basin should be adequate to provide for present and potential beneficial uses. These uses, as described in the foregoing sections, are enumerated as follows:

1. Fisheries
2. Recreation
3. Riparian Dwelling
4. General Public
5. Power
6. Navigation
7. Irrigation and Other Agricultural Uses
8. Municipal and Industrial Water Supply

Based on the uses of water described in the foregoing sections of this report, the critical use is anticipated to be that of fisheries. It should be noted that this use of water occurs in all streams and water bodies of the basin and throughout the year. The water quality needed to serve this use must be adequate for the salmonid species of fish. It is expected that the temperature and dissolved oxygen requirements for this use will become the basis (at this level of study) for establishing stream flow requirements. After such requirements have been determined it will be necessary to examine the result of such stream flows on the other perameters of water quality to see if the remaining water uses can be served. In particular, it will be necessary to examine the amount and types of recreation which the water quality will permit to see if the apparent needs will be met.